SOP-12
Field Classification and Description of Soils and Rock

Yerington Mine Site
Standard Operating Procedure

Revision 0
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SOP-12
FIELD CLASSIFICATION AND DESCRIPTION OF SOILS AND ROCK

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1.0 OBJECTIVES

This objective of this Standard Operating Procedure (SOP) is to establish a consistent method for field staff to follow when completing the description of soil and rock samples obtained from field sampling efforts and entry into borehole logs. Consistency with description is important because during many projects multiple employees may be involved at different times. Hence, being able to compare between logs that were created by different geologists is essential for creating subsurface interpretations.

2.0 SCOPE AND APPLICABILITY

This procedure will be used during all field activities when bore hole subsurface drilling, surface soil or rock sampling, reconnaissance geological mapping is occurring. These activities should be documented as described herein, and following the SOP for Field Notes and Documentation (SOP-03).

3.0 RESPONSIBILITIES

The *Project Manager (PM)* shall ensure that the soil or rock classification and description procedures used in the field conform to the guidelines in this SOP. The PM shall ensure that all field personnel providing descriptions are properly trained to conduct this task and are providing descriptions under the oversight of a Senior Geologist registered in the state in which the logging is occurring. If the state does not have requirements for registration, then the Senior Geologist should meet the standards for a professional geologist under that states law or be registered in another state.

The *Field Supervisor* is responsible for reviewing lithologic logs for accuracy and completeness prior to releasing them to the project manager for review.

The *Field Geologist* is responsible for following the soil classification and description procedures in this SOP, and for accurately and completely representing the lithology encountered in the field

4.0 DEFINITIONS

<u>ASTM</u>. American Society for Testing Materials.

<u>Feldspathoids</u>. Alkali (potassium) or basic (plagioclase) feldspar.

<u>IUSG</u>. International Union of Geological Sciences

<u>USCS</u>. Unified Soil Classification System.

5.0 MATERIALS REQUIRED

The materials required for completing the procedures outlined in this SOP, at a minimum, include the following:

- Hand lens
- Field notebook and borehole log forms
- Protractor

- Pencils
- Pocket knife
- Dilute hydrochloric acid in small dispenser
- Field charts of grain size examples (e.g., American Geological Institute [AGI] data sheets)
- Squirt bottle with water
- Compass with altimeter

6.0 METHODS

The following sections provide guidance for how proper field visual descriptions of soils and rock samples should be conducted. These methods may not be applicable to every soil or rock sample found, but should provide enough guidance to allow accurate and defensible descriptions by a variety of field geologists.

6.1 DESCRIPTION OF SOILS

The following section provides a description of the procedures that should be used when describing soils.

6.1.1 General Considerations

The most popular soil classification method that is based on grain size and other properties, is the Unified Soil Classification System (USCS). This system was initially developed by A. Casagrande in 1948 and was then called the Airfield Classification System. It was adopted with minor modifications by the U.S. Bureau of Reclamation and the U.S. Corps of Engineers in 1952. In 1969, the American Society for Testing and Materials (ASTM) adopted the system. This system is designated currently by ASTM as D-2488-90 and will be used as a guideline for classifying and describing lithology. It requires certain information (e.g. liquid limit, plastic limit moisture content and plasticity index) about the soil which can only be obtained in a laboratory.

The USCS is based on grain size and response to physical manipulation at various water contents. This system is often used for classifying soils encountered in boreholes, test pits, and surface sampling. The following properties form the basis of USCS soil classification:

- Percentage of gravel, sand, and fines;
- Shape of the grain size distribution curve; and
- Plasticity and compressibility characteristics.

Four soil fractions are recognized. They are cobbles, gravel, sand, and fines (silt or clay). The soils are divided as coarse grained soils, fine grained soils, and highly organic soils. The coarse grained soils contain 50 percent of grains coarser than a number 200 sieve (approximately 0.08 mm). Fine grained soils contain more than 50 percent of material smaller than the number 200 sieve. Organic soils contain particles of leaves, roots, peat, etc.

6.1.2 Soil Description Procedures

The following will be used as a guideline for logging lithology from subsurface activities (i.e. borehole drilling, trenching, etc.).

The USCS recognizes 15 soil groups and uses names and letter symbols to distinguish between these groups. The coarse grained soils are subdivided into gravels (G) and sands (S). Both the gravel and sand groups are divided into four secondary groups. Fine grained soils are subdivided into silts (M) and clays (C).

Soils are also classified according to their plasticity and grading. Plastic soils are able to change shape under the influence of applied stress and to retain the shape once the stress is removed. Soils are referred to either low (L) or high (H) plasticity. The grading of a soil sample refers to the particle size distribution of the sample. A well graded (W) sand or gravel has a wide range of particle sizes and substantial amounts of particles sized between the coarsest and finest grains. A poorly graded (P) sand or gravel consists predominately of one size or has a wide range of sizes with some intermediate sizes missing.

Soils which have characteristics of two groups are given boundary classifications using the names that most nearly describe the soil. The two groups are separated by a slash. The same is true when a soil could be well or poorly graded. Again the two groups are separated by a slash.

Soil description should be concise and stress major constituents and characteristics for fine-grained, organic, or coarse-grained soils. Tables 1 and 2 are checklists for descriptions of fine-grained, organic soils, and coarse-grained soils, respectively. Field descriptions should include as a minimum:

> <u>Soil name</u>. The basic name of the predominant constituent and a single-word modifier indicating the major subordinate constituent.
>
> <u>Particle Size Distribution</u>. An estimate of the percentage and grain-size range of each of the soil's subordinate constituents with emphasis on clay-particle constituents. This description may also include a description of angularity. This parameter is critical for assessing hydrogeology of the site and should be carefully and fully documented.
>
> <u>Gradation or Plasticity</u>. For granular soil (sands or gravels) that should be described as well-graded, poorly graded, uniform, or gap-graded, depending on the gradation of the minus 3-inch fraction. Cohesive soil (silts or clays) should be described as non-plastic, low plastic, medium plastic, or highly plastic.
>
> <u>Dry Strength</u>. Dry strength describes the crushing characteristics of a dry soil crumb about ¼ inch (5 mm) in diameter. If a crumb of dry soil is not available, after removing particles larger than No. 40 sieve size, mold at least three balls of soil about ¼ inch (5 mm) in diameter to the consistency of putty, adding water if necessary. Allow the balls to dry completely by oven, sun, or air drying, and then test their strength by breaking and crumbling between the fingers. This strength is a measure of the character and quantity of the colloidal fraction contained in the soil. The dry strength increases with increasing plasticity.
>
> <u>Dilatancy</u>. Dilatancy describes the soils reaction to shaking. After removing particles larger than No. 40 sieve size, prepare a ball of moist soil about ½ inch (15 mm) in diameter. Add

enough water, if necessary, to make the soil soft but not sticky. Place the ball in the open palm of one hand and shake horizontally, striking vigorously against the other hand several times. A positive reaction consists of the appearance of water on the surface of the ball which changes to a livery consistency and becomes glossy. When the sample is squeezed between the fingers, the water and gloss disappear from the surface, the ball stiffens, and finally cracks or crumbles. The rapidity of appearance of water during shaking and of its disappearance during squeezing assist in identifying the character of the fines in a soil.

Toughness. Toughness is the consistency of the soil near the plastic limit. After removing particles larger than the No. 40 sieve size, mold a ball of soil about ½ inch (15 mm) in diameter to the consistency of putty. If too dry, water must be added and if sticky, the specimen should be spread out in a thin layer and allowed to lose some moisture by evaporation. The specimen is then rolled out by hand on a smooth surface or between the palms into a thread about 1/8 inch (3 mm) in diameter. The thread is folded and rerolled repeatedly. During this manipulation, the moisture content is gradually reduced and the specimen stiffens, finally loses it plasticity, and crumbles when the plastic limit is reached.

Color. The basic color of the soil (refer to Munsell soil color charts).

Odor. Odor is described from a warm, moist sample. The odor should only be described if it is organic or unusual. An organic odor will have distinctive decaying vegetation smell. Unusual odors, petroleum product, chemical, and the like should be described.

Soil Texture and Structure. Description of particle size distribution, arrangement of particles into aggregates, and their structure. This description includes joints, fissures, slicked sides, bedding, veins, root holes, debris, organic content, and residual or relict structure, as well as other characteristics that may influence the movement or retention of water or contaminants.

Moisture Content. The amount of soil moisture described as dry, moist, or wet/saturated.

Relative Density or Consistency. An estimate of density of a fine-grained soil or consistency of a cohesive soil, usually based on standard penetration tests.

Cementation. An estimate of cementation of a coarse-grained soil.

Relative Permeability. An estimate of the permeability based on visual examination of materials (e.g., high permeability for course sand and gravel verses low permeability for silty clay). The estimate should address presence and condition of fractures (open, iron-stand, calcite-filled, open but claylined, etc.), as well as fracture density and orientation;

Local Geologic Name. Any specific local name or generic name (i.e., alluvium, loess).

Group Symbol. USCS of symbols.

The soil logs should also include a complete description of any tests run in the borehole; placement and construction details of piezometers, wells, and other monitoring equipment; abandonment records; geophysical logging techniques used; and notes on readings obtained by air monitoring instruments.

The following tables outline the criteria used for determining the descriptive classification of soils based on simple field tests.

Criteria for Describing Plasticity

Descriptive item	Criteria
Nonplastic	A 1/8 inch (3 mm) thread cannot be rolled at any moisture content.
Low	The thread can barely be rolled and the lump cannot be formed when drier than the plastic limit.
Medium	The thread is easy to roll and not much time is required to reach the plastic limit. The thread cannot be rerolled after reaching the plastic limit. The lump crumbles when drier than the plastic limit.
High	It takes considerable time rolling and kneading to reach the plastic limit. The thread can be rerolled several times close to the plastic limit. The lump can be formed without crumbling when drier than the plastic limit.

Criteria for Describing Dry Strength

Descriptive item	Criteria
None	The dry specimen crumbles into powder with mere pressure of handling
Low	The dry specimen crumbles into powder with some finger pressure.
Medium	The dry specimen breaks into pieces and crumbles with considerable finger pressure.
High	The dry specimen cannot be broken with finger pressure. Specimen will break into pieces between thumb and a hard surface.
Very high	The dry specimen cannot be broken between the thumb and a hard surface.

Criteria for Describing Dilatancy

Descriptive item	Criteria
None	No visible change in the specimen
Slow	Water appears slowly on the surface of the specimen during shaking and does not disappear, or disappears slowly upon squeezing.
Rapid	Water appears quickly on the surface of the specimen during shaking and disappears quickly upon squeezing.

Criteria for Describing Toughness

Descriptive item	Criteria
Low	Only slight pressure is required to roll the thread near the plastic limit. The thread and lump are weak and soft.
Medium	Medium pressure is required to roll the thread to near the plastic limit. The lump and thread have medium stiffness
High	Considerable pressure is required to roll the thread to near the plastic limit. The thread and the lump have very high stiffness.

Criteria for Describing Moisture

Descriptive item	Criteria
Dry	Absence of moisture, dusty, dry to the touch
Moist	Damp but no visible water
Wet/saturated	Visible free water, usually soil is below water table.

Structure (for description of soils only)

Descriptive item	Criteria
Stratified	Alternating layers of varying material or color with layers at least 6 mm (1/4 inch) thick; note thickness
Laminated	Alternating layers of varying material or color with layers less than 6 mm (1/4 inch) thick; note thickness.
Fissured	Breaks along definite planes of fracture with little resistance to fracturing.
Slickensided	Fracture planes appear polished or glossy, sometimes striated (parallel grooves or scratches)
Blocky	Cohesive soil that can be broken down into small angular lumps which resist further breakdown.
Lensed	Inclusion of small lenses of sand scattered through a mass of clay; note thickness.
Homogeneous	Same color and appearance throughout.

Criteria for Describing Consistency

Descriptive item	Criteria
Very soft	Thumb penetrates soil more than 1 inch
Soft	Thumb penetrates about 1 inch
Firm	Thumb indentation up to ¼ inch
Hard	No indentation with thumb, readily indented with thumbnail
Very Hard	Not indented with thumbnail

Criteria for Describing Cementation

Descriptive item	Criteria
Weak	Crumbles or breaks with handling or little finger pressure.
Moderate	Crumbles or breaks with considerable finger pressure.
Strong	Will not crumble or break with finger pressure.

6.2 DESCRIPTION OF ROCK

The following section provides a description of the procedures that should be used when describing rock samples.

6.2.1 General Considerations

Rock identification is based on minerals and textures. Drilling in rock will be slow and core recovery may consist of pulverized chips. The proper drilling technique is necessary for adequate recovery and accurate rock identification.

6.2.2 Rock Description Procedures

Rocks can be categorized into three types: sedimentary, igneous, and metamorphic. Descriptions for these three types of rocks are different. The following procedures are organized following the three categories.

***Sedimentary Rock Classification*.**

Sedimentary rocks result from two processes (and combinations thereof):

- Consolidation of loose sediments that have accumulated in layers, forming *clastic rocks*.
- Precipitation from solution to form a *chemical rock*. Included in this category are rocks directly or indirectly formed by biological processes.

The following text summarizes how to characterize these two types of sedimentary rock.

Clastic Rocks. Clastic rocks have been classified different ways. They may be classified according to the size of particles, sorting, and distribution of particles, or chemical content of silica, feldspar, and calcite.

Grain Size. In the most commonly used classification system, the size of the particles determines the general rock name. For example, sand-sized particles for sandstones; pebbles form conglomerates, and so on. The rack names are shown in the table below along with their component particle sizes. The divisions in the classification are based upon the Modified Wentworth scale used to measure grain size.

Grain Size Scale (Modified Wentworth Scale)

Diameter (in)	Particle	Sediment	Rock
< 0.0002	Clay	Mud	Claystone, mudstone, shale
0.0002 to 0.002	Silt		Siltstone
0.002 to 0.08	Sand	Sand	Sandstone
0.08 to 2.5	Pebble		Conglomerate (rounded)
2.5 to 11.8	Cobble	Gravel	
> 11.8	Boulder		Breccia (angular)

Conglomerates and breccias have adjectives such as *clast-supported and matrix supported*. *Clast-supported* means that he clasts are sorted well enough so that the large clasts touch, and *matrix-supported* is not.

A well-sorted sandstone is called an arenite. A poorly sorted sandstone with a matrix of silt and clay is called a wacke. A sandstone with more than 25% feldspar is an arkose. And, if lithic fragments or iron and magnesium minerals and feldspar are present along with quartz sand and silt, the rock is called a graywacke.

Sorting. Sedimentary rock names are further characterized by the sorting the particles have undergone. The distribution of grain sizes reflects the type of transport a sediment has experienced and the depositional environment. A well-sorted (or poorly graded) sediment has two or three sizes present. A poorly sorted (or well-graded) sediment has a wide range of grain sizes present.

Cementation. Cementing substances have usually been referred to by adjectives such as calcareous, dolomitic, and siliceous; however, these terms might also imply accessory detrital materials, so that the unambiguous terms calcite-cemented, dolomite-cemented, and quartz-cemented are recommended.

Chemical Rocks. Chemical rocks have been classified according to chemical composition, depositional texture, and depositional environment.

Common chemical rocks are limestone, dolomite, evaporites (gypsum, anhydrite, halite, etc.) phosphate rocks (apatite), manganese nodules, ironstones (limonite, siderite, and chlorite silicates), coal, pyrite, chert, and diatomite, and some cherts have a biogenic component to their formation.

***Igneous Rock Classification*.**

Classification of igneous rocks is based upon the mineral content of the rock. Minerals upon which the classification is based are feldspar, quartz (or feldspathoids), and mafic minerals such as biotite, hornblende, pyroxene, and olivine. Of these minerals, identifying feldspar is the key to classification.

The International Union of Geological Sciences (IUGS), Sub commission on the Systematics of Igneous Rocks attempted to create a universal classification of igneous rocks. The committee's recommendations for plutonic and volcanic rocks are shown in the following two tables, respectively. A rock is classified by determining it composition relative to the percentage of alkali feldspar, plagioclase, and quartz (or feldspathoid).

Modal Classification of Plutonic Igneous Rocks

Modal Values	Classification
Q > 60	Not igneous
Q = 20-60, P <10	Alkali feldspar granite
Q = 20-60, P = 10-65	Granite
Q = 20-60, P = 65-90	Granodiorite
Q = 20-60, P >90	Tonalite
Q = 5-20, P <10	Alkali feldspar quartz syenite
Q = 5-20, P = 10-35	Quartz syenite
Q = 5-20, P = 35-65	Quartz monzonite
Q = 5-20, P = 65-90	Quartz monzodiorite (An < 50), Quartz monzogabbro (An > 50), Quartz anorthosite (M < 10)
Q = 5-20, P >90	Quartz diorite (An < 50), Quartz gabbro (An > 50), Quartz anorthosite (M < 10)
Q = 0-5, P <10	Alkali feldspar syentie
Q = 0-5, P = 10-35	Syenite
Q = 0-5, P = 35-65	Monzonite
Q = 0-5, P = 65-90	Monzodiorite (An < 50), Monzogabbro (An > 50), Anorthosite (M < 10)
Q = 0-5, P >90	Diorite (An < 50), Gabbro (An > 50), Anorthosite (M < 10)
F = 0-10, P <10	Foid-bearing alkali feldspar quartz syenite
F = 0-10, P = 10-35	Foid-bearing syenite
F = 0-10, P = 35-65	Foid-bearing monzonite
F = 0-10, P = 65-90	Foid-bearing monzodiorite (An < 50), Foid-bearing monzogabbro (An > 50)
F = 0-10, P >90	Foid-bearing diorite (An < 50), Foid-bearing gabbro (An > 50)
F = 10-60, P <10	Foid syenite
F = 10-60, P = 10-50	Foid monzosyenite
F = 10-60, P = 50-90	Foid monzodiorite (An < 50) Foid monzogabbro (An > 50)
F = 10-60, P >90	Foid diorite (An < 50), Foid gabbro (An > 50)
F > 60	Foidolites

Q = quartz/(quartz = alkali feldspar = plagioclase)
F = feldspathoids/(feldspathoids = alkali feldspar)
P = feldspathoids/(feldspathoids = plagioclase feldspar)
M = color index
An = % anorthite inplagioclase

Modal Classification of Volcanic Igneous Rocks

<table>
<tr><th>Modal Values</th><th>Classification</th></tr>
<tr><td>Q > 60</td><td>Not igneous</td></tr>
<tr><td>Q = 20-60, P <10</td><td>Alkali feldspar rhyolite</td></tr>
<tr><td>Q = 20-60, P = 10-65</td><td>Rhyolite</td></tr>
<tr><td>Q = 20-60, P = 65-90</td><td>Dacite</td></tr>
<tr><td>Q = 20-60, P >90</td><td>Dacite</td></tr>
<tr><td>Q = 5-20, P <10</td><td>Alkali feldspar quartz trachyte</td></tr>
<tr><td>Q = 5-20, P = 10-35</td><td>Quartz trachyte</td></tr>
<tr><td>Q = 5-20, P = 35-65</td><td>Quartz latite</td></tr>
<tr><td>Q = 5-20, P = 65-90</td><td rowspan="6">In all six fields, the names andesite and basalt are applied; basalt is used if SiO_2 < 52wt % after H_2O and CO_2 are deleted and the analysis recalculated to sum 100%</td></tr>
<tr><td>Q = 5-20, P >90</td></tr>
<tr><td>Q = 0-5, P = 65-90</td></tr>
<tr><td>Q = 0-5, P >90</td></tr>
<tr><td>F = 0-10, P = 65-90</td></tr>
<tr><td>F = 0-10, P >90</td></tr>
<tr><td>Q = 0-5, P <10</td><td>Alkali feldspar trachyte</td></tr>
<tr><td>Q = 0-5, P = 10-35</td><td>Trachyte</td></tr>
<tr><td>Q = 0-5, P = 35-65</td><td>Latite</td></tr>
<tr><td>F = 0-10, P <10</td><td>Foid-bearing alkali feldspar quartz trachyte</td></tr>
<tr><td>F = 0-10, P = 10-35</td><td>Foid-bearing trachyte</td></tr>
<tr><td>F = 0-10, P = 35-65</td><td>Foid-bearing latite</td></tr>
<tr><td>F = 10-60, P <10</td><td>Phonolite</td></tr>
<tr><td>F = 10-60, P = 10-50</td><td>Tephritic phonolite</td></tr>
<tr><td>F = 10-60, P = 50-90</td><td>Phonolitic tephrite</td></tr>
<tr><td>F = 10-60, P > 90</td><td>Tephrite (olivine < 10%)
Basanite (olivine > 10%)</td></tr>
<tr><td>F > 60</td><td>Foidite</td></tr>
</table>

Q = quartz
P = feldspathoids/(feldspathoids = plagioclase feldspar)
F = feldspathoids/(feldspathoids = alkali feldspar)

***Metamorphic Rock Classification*.**

In this binomial system for naming metamorphic rocks, the main rock name is based on the texture of the rock, and the principal or more significant minerals are added as modifying nouns, as in biotite-quartz schist or andalusite-cordierite hornfels. The names are meant to be applied on a descriptive basis; a schistose rock, for example, should not be called a hornfels just because it is found in a contact aureole.

Textures.

- Schistose – grains platy or elongate and oriented parallel or subparallel. *Foliated* (lepidoblasitc) of fabric is planar, *lineated* (nematoblastic) if linear.
- Granobalstic – grains approximately equidimensional; platy and linear grains oriented randomly or so subordinate that foliation is not developed.
- Hornfelsic – grains irregular and interincluded but generally microscopic; recognized in field by unusual toughness, ring to hammer blow, and hackly fracture at all angles. Under hand lens, freshly broken surfaces show a sugary coating that will not rub off (formed by rending of interlocking grains).
- Semischistose (gneissic) – platy or linear grains subparallel but so subordinate or so unevenly distributed that rock has only a crude folliation; especially common in metamorphosed granular rocks, such as sandstones and igneous rocks.
- Cataclastic – clastic textures resulting from breaking and grinding with little if any recrystallization; characterized by angular, lensoid, or rounded fragments (porphyroclasts) in a fine-grained and commonly streaked or layered
- Groundmass. *Mortar structure* applies to nonorientated arrangements, and *phacoidal*, *flaser*, and *augen structure* apply to lenticular arrangements.

Rock Names.

Schistose Rocks.

- Schist – grains can be seen without using a microscope.
- Phyllite – all (or almost all) grains of groundmass are microscopic, but cleavage have sheen caused by reflections from platy or linear minerals; commonly corrugated.
- Slate – grains are microscopic; very cleavable; surface dull; tougher than shale and cleavage commonly oblique to bedding.
- Phyllonite – appearance like phyllite but formed by cataclasis (see mylonite) and recrystallization commonly of coarser-grained rocks, as indicated by relict rock slices, slip folds, and prophyroclasts.

Granoblastic Rocks.

- Granulite or Granofels – granoblastic rocks, irrespective of mineral composition; because granulite can connote special compositions and conditions or origin, granofels may be preferred.
- Quartzite, marble, and amphibolite – compositional names that generally connote granoblastic texture; exceptions should be modified for clarity, as schistose quartzite or plagioclase hornblende schist.
- Tactite (skarn) – heterogeneous calc-sillicate granulites and related metasomatic rocks of typically uneven grain.

Hornfelsic Rocks.

- All called hornfels, or, if relict features are clear, hornfelsic may be used with the original rock name (as hornfelsic andesite)

Semi-schistose (Gneissic) Rocks.

- Semi-schist – fine-grained (typically less than 1.4 mm) so that individual platy or lineate grains are indistinct; relict features often common.
- Gneiss – generally coarser than ½ mm with small aggregates of platy or lineate grains forming separate lenses, bladed, or streaks in otherwise granoblastic rock. Platy or lineate structures may be distributed evenly through the rock or may be concentrated locally so that some layers or lenses are granoblastic or schistose (banded gneiss).

Cataclastic Rocks. Where original nature of rock is still apparent, rock name can be modified by suitable adjectives (as cataclastic granite, flaser gabbro, phacoidal rhyollite).

- Mylonite – crushing so thorough that rock is largely aphanitic and commonly dark-colored; may be layered and crudely folliated but not schistose like phyllonite; porphyroclasts commonly rounded or lenticular.
- Ultrmylonite, pseudotachyylyte – aphanitic to nearly vitreous-appearing dark rock commonly injected as dikes into adjoining rocks.

Relict and Special Textures and Structures. If textures of low-grade metamorphic rocks are dominantly relict, original rock names may be modified (as massive metabasalt, semischistose met-andesite). If hydrothermal alteration has produces prominent new minerals, names such as chloritized diorite and sercitized granite can be used.

- Strongly metasomatized rocks with coarse or unusual textures may require special names such as gneissen, quartz-schorl rock, and corundum-mica rock.
- Magmatite – a composite rock composed of igneous or igneous-appearing and/or metamorphic materials that are generally distinguishable megascopically.

7.0 REFERENCES

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8.0 ATTACHMENTS

Attachment A - Checklist for the Description of Fine-Grained Soils

Attachment B - Checklist for the Description of Coarse-Grained Soils

ATTACHMENTS

Attachment A

Checklist for Description of Fine-grained and Organic Soils

Items of descriptive data	Typical information desired for silt and clay
Group name	SILT, LEAN CLAY, ETC., include cobbles and boulders in typical name when applicable.
Size distribution	Approximate percent of fines, sand, and gravel of fraction less than 3 inch in size; must add to 100 percent
Plasticity of fines	Nonplastic; low; medium; high
Dry strength	None; low; medium; high; very high
Dilatancy	None; slow; rapid
Toughness near plastic limit	Low; medium; high
Moisture condition	Dry; moist; wet
Color	Munsell color chart; if possible, note mottling or banding
Odor	Only mention of organic or related to contaminants
Structure	Stratified; laminated; fissured; slickensided; blocky; lensed; homogeneous
Consistency	Very soft; soft; firm; hard; very hard
Relative Permeability	Low; medium; high; fractures, open, iron-stand, calcite-filled, open but claylined
Local Geologic Name	If applicable
Group symbol	CL, CH, ML, MH, OL/OH, or appropriate borderline symbol when applicable; should be compatible with typical name used above

Attachment B

Checklist for Description of Coarse-grained Soils

Items of descriptive data	Typical information desired for sand and gravel
Group name	WELL-GRADED GRAVEL WITH SAND, ETC., will include cobbles and boulders in typical name when applicable.
Gradation	Describe range of particle sizes, such as fine to medium sand or fine to coarse gravel, or the predominant size or sizes as coarse, medium. Fine sand or coarse or fine gravel.
Size distribution	Approximate percent of gravel, sand, and fines in the fraction finer than 3 inch; must add to 100 percent.
Plasticity of fines	Nonplastic; low; medium; high
Particle shape	Flat, elongated, or flat and elongated (if applicable)
Particle angularity	Angular; subangular; subrounded; rounded
Moisture condition	Dry; moist; wet
Color	Munsell color chart
Odor	Only mention of organic or related to contaminants
Structure	Stratified; lensed; homogeneous
Cementation	Weak; moderate; strong
Relative Permeability	Low; medium; high; fractures, open, iron-stained, calcite-filled, open but claylined
Local Geologic Name	If applicable
Group symbol	GP, GW, SP, SW, GM, GC, SM, SC, or the appropriate symbol when applicable; should be compatible with typical name used above
Mineralogy	Rock hardness for gravel and coarse sand. Note presence of mica flakes, shaly particles, or organic matter.